Preventing Livestock Deaths From Blue-Green Algae Poisoning

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Cover photo: Cattle drinking from lake water containing waterbloom of blue-green algae

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Blue-green algae poisoning causes disease and death of livestock and other animals that drink from algae-infested water. The problem occurs most in the Midwestern and Western United States and in the prairie provinces of Canada. It also appears in other regions of the world having a similar climate and geography, including areas of Australia, Asia, Europe, and Africa.

Animals that have been poisoned by blue-green algae include cattle, horses, sheep, pigs, chickens, ducks (domestic and wild), pigeons, geese, herons, songbirds, dogs, rabbits, small wild and domestic animals, and even frogs, fish, and snakes.

Few humans are poisoned by toxic algae. Most people avoid the heavy green surface scum of algae on ponds. While no human deaths from blue-green algae poisoning have been proved, accidental ingestion of the water while swimming or boating has caused gastrointestinal distress, and skin contact with the waterbloom irritates the skin.

Poisonous and Nonpoisonous Algae

Algae are plants that grow in either freshwater or saltwater. There are about eight large groups of algae that vary greatly in appearance. They can be as large as giant

Closeup of surface scum near shore, showing thick layer of poisonous algae on rocks

seaweed kelps or as small as a single cell. Three of these eight groups have members which produce poisons capable of killing animals.

One of these three groups, the blue-green algae, is found worldwide, but only a few of its members are poisonous. The known poisonous blue-green algae are microscopic. Although most are freshwater algae, there are some poisonous marine forms.

Under favorable conditions of temperature, nutrients, and light, microscopic algae cells multiply sufficiently to discolor the water. The water will commonly be dark-green to blue-green and occasionally even greenish-brown to red. This heavy concentration of cells is referred to as a waterbloom. If poison-producing algae cells are in the waterbloom, animals drinking the water will become ill and may die.

Because the blue-green algae have many characteristics common to bacteria, some scientists now refer to blue-green algae as cyanobacteria (cyano means blue-green). Despite the similarities, the disease produced by blue-green algae, unlike bacteria-caused diseases, cannot be transmitted between animals. Nor can the organisms grow in an affected animal. Whether an animal lives or dies depends entirely on how many of the poisonous cells and how much of the poison they secrete are in the water the animals consume (fig. 1). This fact makes it possible to take some basic precautions to prevent animal poisonings by blue-green algae.

Where and When Waterblooms Occur

Most waterblooms are in freshwater and almost any body of water can produce them. The blooms are

Surface of water body showing one type of shape for the algae clumps as they float near the surface

most commonly found in inland lakes, ponds, or sloughs.

Because algae are plants, they require light to grow. Their growth is confined to shallow areas of water which allow enough light to penetrate to the bottom. The algae float to the surface and gentle wind and wave action concentrate them near the shore, especially in small, protected places favored by animals as watering areas. If the bloom is poisonous, it takes only a few days of rapid growth in water temperatures around 72°–80°F (21°–27°C) for a lethal concentration of algae to form. This surface scum of algae presents the most dangerous condition for watering animals.

The most favorable conditions for a bloom are the warm, dry, low-wind days of summer and early fall. These weather conditions also seem to promote poisonous blooms in particular. Toxic blooms usually do not last very long. Rain, wind, or cooler weather often inhibit growth or break up a bloom and mix it into the water body within a few days. However, blooms may last several weeks in reservoirs, lakes, or ponds subjected to continuous hot, dry, calm weather. Blooms may also reoccur if the weather again becomes suitable. Nutrients in the water help determine if a bloom will occur. Agricultural runoff into surface water favors heavy growths of poisonous and nonpoisonous algae.

Signs of Poisoning

The symptoms of poisoning and their degree of severity depend on the species of animal, the amount of poison ingested, and the type of poison in the bloom. Some blue-green algae produce alkaloid poisons which affect the nervous system and cause suffocation. Other blue-green algae produce polypeptide poisons which lead to rapid degeneration of internal organs, especially the liver.
These peptide toxins can also cause heart failure and microscopic, multifocal pulmonary vascular thrombi in affected animals. Pathological effects of the toxin on the liver once thought due to direct action on hepatic cells, are probably

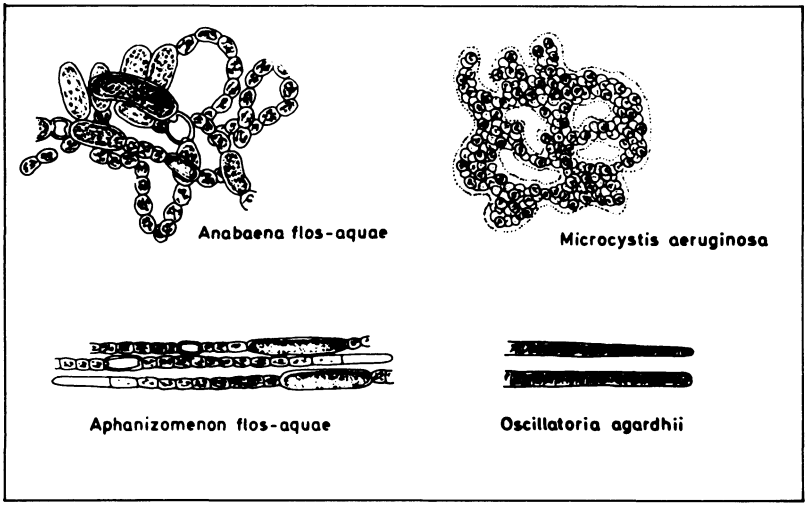

Figure 1—Line drawings of common bloom-forming blue-green algae known to produce poisons. Each cell is about 10-15 micrometers long or 0.000254-0.000381 inches.

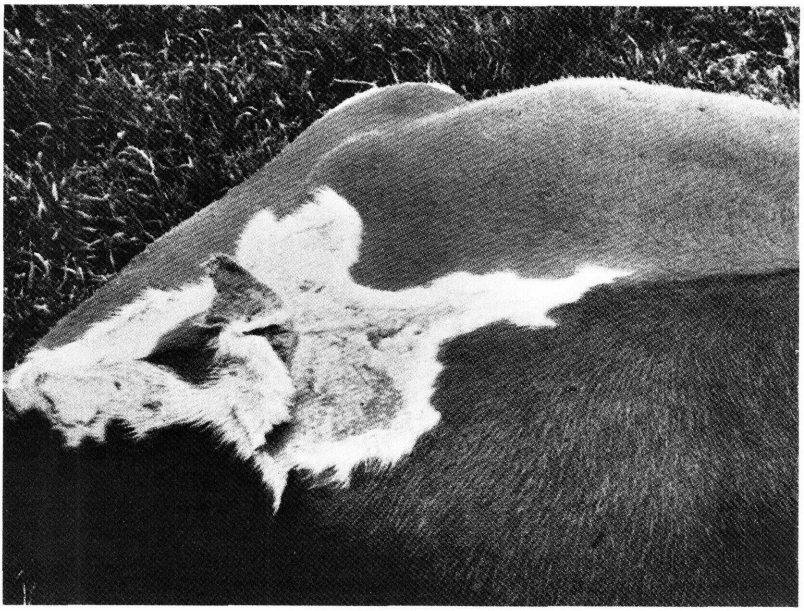

Figure 2—Skin sloughing of cattle, a response to pigments in the algae cells common to both toxic and nontoxic algae.

the result of cardiac failure of the right ventricle and shock.

If an animal ingests both poisons—the alkaloids and the polypeptide poisons—its nervous system and liver could be affected. Death would probably be caused by suffocation, because alkaloids act much faster than polypeptides. The latter may take several hours to kill an animal.

In most cases investigated, most of the affected animals die. Survivors vary in rate of recovery, depending on amounts of toxin ingested.

Survivors exhibit lethargy, loss of appetite, and loss of weight, and pregnant female survivors abort fetuses. All of these conditions can affect the animals' marketability for weeks, even months. The toxin residues in the animal tissue, however, would not be a threat to humans or animals. Other signs of algae poisoning include photosensitization (fig. 2) or rigid extension of legs and neck (fig. 3). Photodynamic toxins formed by algae cause photosensitivity in susceptible animals in light-skinned areas of the nose, face, back, escutcheon, and udder. The signs are reddening, blistering, swelling of tissue beneath the skin due to leakage of serum from damaged capillaries, death of tissue, and sloughing of skin. The animal experiences intense itching and rubs areas involved, which produces further injury to tissue and secondary bacterial infection.

Table 1 shows the approximate amounts animals must consume to cause death. Table 2 summarizes major signs of poisoning observed in affected animals.

Laboratory Identification of Poisonous Waterblooms

Some states have water-quality laboratories, public health departments, or other agencies which are authorized to do chemical analyses of waterbloom or animal tissue samples to confirm the presence of toxic algae. Such a laboratory will

Figure 3—Sign of poisoning typical for blue-green algae that produces a neuropoison. A and C show the characteristic rigid extension of legs and neck. "B" shows a paralysis more typical of avian species affected by a neuropoison such as fowl botulism.

base a confirmation of a poisonous bloom on identification of the algae present in the water sample; demonstration of acute toxicity in laboratory mice after injection of algae; and the presence of algae cells in the stomach or feces of a dead animal.

To collect a waterbloom sample for analysis, use a clean, water-tight, pint-size container. Rinse the container thoroughly with the lake or pond water, then scoop up a concentrated sample of the surface scum. If the bloom is widespread, use a second container to take another sample from a different location. Keep the sample (or samples) refrigerated (but not frozen) and submit it for analysis within 2-3 days.

The water sample can be used directly for small animal bioassay such as intraperitoneal injection (i.p.) of a mouse. The interpretation of the mouse bioassay test should be based on 0.5 ml i.p. injections into sibling litter mates of laboratory mice weighing 15-25 g. This method will detect the presence of poisons at even low concentrations.

A history of the algae poisoning is important. Write down all data about the species and number of animals you think have been affected, the location of dead or sick animals in relation to the source of water, the appearance of the waterbloom, the weather at the time of poisoning, and the signs of poisoning observed.

The preferred method of collecting tissue samples from a dead animal is to have a veterinarian or one of the laboratory personnel take the samples. If this is not possible, remove and refrigerate specimens of the animal's liver, kidney, heart, and stomach contents, and deliver them to the laboratory for examination within 2-3 days. A feces sample should also be taken to check microscopically for algae.

Table 1 —Blue-Green Algae Waterbloom Concentration Capable of Causing Animal Death

Animal	Weight	Approximate amount of bloom ingested to produce death
		Fluid ounces
Calf	220 lbs (100 kg)	45 (1.3 liter)
Duck	4.5 lbs (2 kg)	1.2 (40 ml)
Fish	1 ounce (30 g)	0.2 (7 ml)

Preventive Measures

There currently exists no known antidote against any of the algal toxins. Even if one existed, the alkaloid poisons act so fast that the animal owner often does not have enough time to recognize that algal poisoning is involved before the animal dies. The best way to prevent animal losses is to be aware of conditions that can produce a poisonous bloom and to keep animals from drinking the surface scum.

Check all livestock watering areas in hot, dry weather for light to heavy green coloration of the water body. If a surface scum is present, consider it a possible poisonous bloom.

Not all blooms, of course, are toxic blue-green algae. Mats of algae floating on or below the surface which have a stringy texture and can be picked up are probably harmless green algae. All toxic or potentially toxic blue-green algae form surface scums especially inshore or in protected bays. These scums are not stringy but slippery, clotted masses of cells which readily fall apart when picked up.

Keep livestock and pets away from the bloom and use an alternate water supply. If no such supply exists, allow livestock to drink only on the upwind side of the water where the bloom has not drifted.

It is also possible to construct a floating barrier to keep the surface scum (top 4 inches of the water) away from the area where animals drink. The barrier can be built of logs, styrofoam, or other floating material. It should isolate the drinking area completely and not allow the surface scum to leak past. The barrier should be far enough from shore and over deep enough water so that animals will not be able to drink beyond it.

It is not practical to use a barrier to clear off the scum, but only to keep scum out of places where it has not yet drifted. In all instances involving a surface scum, preventive action is necessary to assure that no animals are lost. It will take analysis of the water to determine if a toxic species of blue-green algae is present, however.

Chemical Control

If toxic waterblooms occur repeatedly during the summer or from year to year, it is possible to apply an algicide to the water body. Use of algicides in most States may be regulated by the Department of Natural (or Environmental) Resources in the State, and an algicide permit may be required.

Consult the appropriate water management authority to get advice on algicide use and restrictions before you purchase an algicide.

The most effective algicide is copper sulfate ($CuSO_4 \cdot 5H_2O$), which can be purchased in granular or block form (sometimes called blue stone). Currently, no Federal regulations exists on the use of $CuSO_4$ in water supplies. A level of 1 ppm (mg/1) is considered the upper limit for drinking water to avoid taste problems.

The usual application for control of blue-green algae is 0.75 pound per acre spread as evenly as possible over the entire water surface. If blocks of copper sulfate are used, they can be placed in a porous bag such as burlap and towed behind a small boat. You can also suspend the bags in the water using plastic jugs or styrofoam as a float.

The treatment described is most effective when applied just as the bloom is forming. Repeat the application every 2-3 weeks throughout the bloom-forming season.

For Further Reading

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Table 2—Signs of Poisoning in Domestic Animals from Freshwater Blue-Green Algae Blooms

Toxin	Time[1]	External Signs[2]	Internal Damage
Alkaloid poison	4-10 minutes	*Extreme:* Muscular tremors, stupor, staggering, collapse, extremely sensitive to touch, convulsions, head extended over back, and death.	No specific damage.
	15-30 minutes	*Severe:* Very sudden onset of signs, weakness, staggering, collapse, muscle twitching, labored breathing, frothy fluids from mouth and nose, wheezing, choking, convulsions, head extended over back, subnormal temperature, coma, and death.	Congestion of brain, spinal cord, and brain membranes. Bloody fluids in lungs and chest cavity. Lungs filled with fluid and bronchial tubes filled with frothy slime.
Polypeptide poison	30 minutes to 24 hours	*Gastrointestinal and kidney:* Weakness, nausea, vomiting, swallowing motions, salivation, eye-watering, severe thirst, sudden excretion, blood-covered hard feces, diarrhea, hair erect, lethargy, distended abdomen.	Bloody digestive tract, bleeding of the mouth, patches of bleeding in intestine, shedding of stomach lining, inflamed intestines, blood-tinged abdominal fluid. Death of renal tissue plus cloudy swelling and hemorrhage of the renal tubules.
		Liver: Jaundice, shock, cold extremities, anemia, pallor, abdominal pain.	Liver swollen, mottled, and dark. Liver tissue easily torn or flabby. Cut surface pale and fatty. *Microscopic damage:* Tissue death from blood coagulation, loss of internal liver structure, ruptured cells, cirrhosis in survivors.

Toxin	Time[1]	External Signs[2]	Internal Damage
Polypeptide poison	30 minutes to 24 hours	*Lungs:* Normal	Microscopic multifocal pulmonary vascular thrombi. Thrombi not attached to layers of cells lining blood vessels and are resistant to common anticoagulants.
		Heart: Rapid, weak pulse; congestive heart failure.	Heart dilated, blood-filled, flaccid. Spot bleeding of heart muscles, blood-tinged fluids in tissues surrounding heart.
Light-sensitive pigment[3]	Several days	Blisters and peeling on white or light skin areas (ears, nose, and tail of sheep; white skin of cattle, horses, and goats), from ingestion of the bloom material.	

[1]The survival time is related to the amount ingested. The greater the dose, the faster the onset of signs.
[2]This is a compilation of toxicity signs observed in all animals. Signs vary according to the species affected.
[3]Symptomatic of ingestion of toxic and nontoxic algae as well as certain drugs and poisonous weeds.